VARIATION OF DRAG COEFFICIENT (C_D) AS A FUNCTION OF WIND BASED ON PANTANAL GRADIENT OBSERVATION FOR DRY SEASON

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RESUMO

Neste trabalho determinou-se o coeficiente de arrasto (C_D) para a região do Pantanal Sul Matogrossense, com base em dados observados do gradiente de vento obtidos a partir de um experimento de campo, realizado durante setembro-outubro de 1996. Os resultados mostraram valores baixos de C_D, os quais podem ser devidos à presença de estruturas coerentes, que devem ser melhor investigadas.

INTRODUCTION

Determination of surface drag is very important in micrometeorological observations as an essential first step. This is useful to acquire knowledge about the terrain fetch conditions and to parametrize vertical turbulent transport of momentum, heat and water vapour. The most widely used bulk aerodynamic formula for the momentum transport requires the specification of the value of a drag coefficient, which can be estimated from the measurements made in a field experiment. There are some field experiments over the oceans and over the land region, but none under wide changing conditions like the Pantanal wetlands. The main aim of this work is to provide a drag coefficient for the Pantanal region based on the gradient observation data obtained in the field experiment during September-October 1996.

TOWER DESCRIPTION AND INSTRUMENTATION

The place selected for the experiment was in the Pantanal wetland of South Mato Grosso State. Measurements were made using a 21 m iron tower at the Base Site of Pantanal Studies (19°58'S; 57°02'W), near Miranda's river, located in Passo da Lontra, MS. The altitude of the tower site is approximately 80 m above the mean sea level. The base belongs to the Federal University of Mato Grosso do Sul (UFMS). The region vegetation is characterized by savanna, with grass and some sparse trees, namely "paratudais" (Magalhaes, 1992; Por, 1995).

Near the tower, in the predominant prevailing wind direction, which was between north and west, the fetch was vast, open and flat over a long distance of about 1km. On the eastern and southern sides there is a closed vegetation or gallery forest ("mata ciliar") and a building, respectively.

The experiment was conducted in September – October 1996, during the dry season. Data selected comprise of measurements made by cup and sonic anemometers and slow response temperature/humidity sensors mounted on the tower. The sonic anemometers (Solent, model 1012 R 2A) were placed at 25 and 19.4m above the surface, and the data from both instruments were obtained at 21Hz approximately. A microcomputer was used to acquire the data. The cup anemometers (Campbell, model 014A) and temperature/humidity sensors (Campbell, model HMP35C) were placed at five heights on the tower, namely 8, 10, 13, 18 and 21.6m above the surface. Data from all of these instruments were recorded at the frequency of 10 minutes in a data logger.

METHODOLOGY

The drag coefficient (C_D) was estimated using the formula

$$C_D = \left(\frac{u_*}{u_{10}} \right)^2$$

where u_{10} is the mean wind at 10 meters, u_* is the friction velocity (ms^{-1}) which is estimated from flux data using the relation (Rao, 1996):

$$u_* = \frac{(u_2 - u_1)}{\left(\frac{1}{k}\right)\ln\left(\frac{z_2}{z_1}\right)} - \psi_1 \quad \text{for unstable case, and}$$

$$u_* = \frac{(u_2 - u_1)}{\left(\frac{1}{k}\right)\ln\left(\frac{z_2}{z_1}\right) + 4.7\frac{z}{L}} \quad \text{for stable case}$$

u_1 and u_2 are the wind speed measured at 8 m (z_1) and 21.6 m (z_2), respectively, k is von Karman's constant (= 0.4) and ψ_1 is given by:

$$\psi_1 = 2\ln\left(\frac{1+x}{2}\right) + \ln\left(\frac{(1+x)^2}{2}\right) - 2\tan^{-1}x + \frac{\pi}{2}$$

and $x = \left(1 - 15\frac{z}{L}\right)^{\frac{1}{4}}$

RESULTS

Figure 1 shows the variation wind at 10 meters with wind direction. It should be mentioned here that wind direction was measured at 19.4 m. The graph shows that on both days 276 and 277 (October 2 and 3, respectively) the predominant wind direction is between 90° and 180° and 90° and 270°, respectively. The drag coefficients are shown in Figure 2 for the days 276 and 277. The variation with wind speed is decreasing with increasing wind speed. The highest value of the drag coefficient, 0.04,

was on day 276, with a corresponding wind speed of 1.5 ms^{-1}. On day 277 it is still less, 0.015, at wind speed of 2 ms^{-1} The values point out that the drag coefficient at the Pantanal site is low. This may be due to coherent structures present, which is to be further investigated.

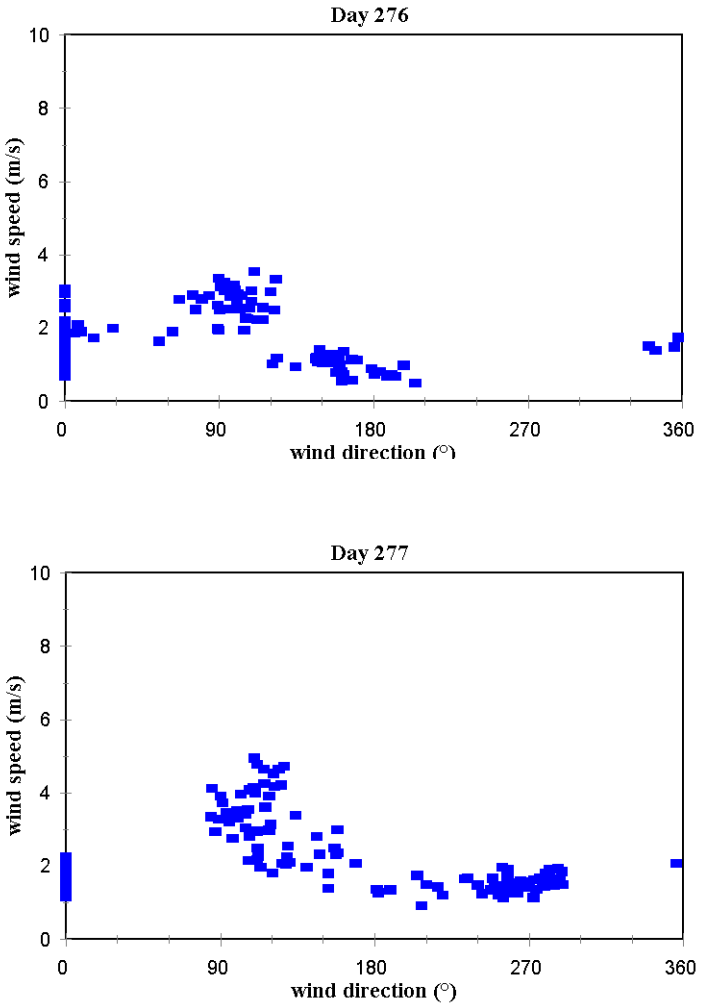

Fig. 1 – Variation of wind speed at 10 m with wind direction at 19.4 m

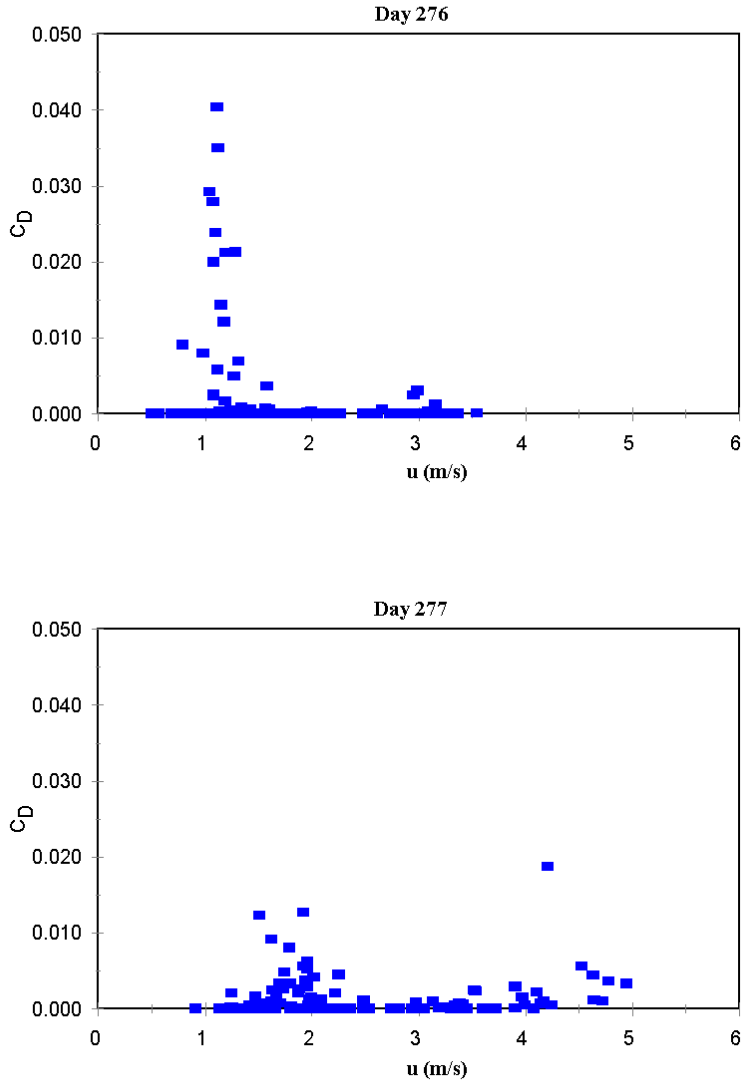

Fig. 2 – Variation of drag coefficient with wind speed measured at 10 m.

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